

# Chapter D5: RUM Analysis

## INTRODUCTION

This case study uses a random utility model (RUM) approach to estimate the effects of improved fishing opportunities due to reduced impingement and entrainment (I&E) in the Tampa Bay Region. Cooling Water Intake Structures (CWISs) withdrawing water from Tampa Bay impinge and entrain many of the species sought by recreational anglers. These species include spotted seatrout, black drum, sheepshead, pinfish, and silver perch.

The study area includes Tampa Bay itself and coastal sites to the north and south of Tampa Bay. The study includes sites in five counties:

- ▶ Pasco,
- ▶ Pinellas,
- ▶ Hillsborough,
- ▶ Manatee, and
- ▶ Sarasota.

The study's main assumption is that anglers will get greater satisfaction, and thus greater economic value, from sites where the catch rate is higher, all else being equal. This benefit may occur in two ways: first, an angler may get greater enjoyment from a given fishing trip when catch rates are higher, and thus get a greater value per trip; second, anglers may take more fishing trips when catch rates are higher, resulting in greater overall value for fishing in the region.

The following sections focus on the data set used in the analysis and analytic results. Chapter A10 of Part A provides a detailed description of the analysis methodology.

## D5-1 DATA SUMMARY

EPA's analysis of improvements in recreational fishing opportunities in the Tampa Bay Region relies on a subset of the 1997 Marine Recreational Fishery Statistics Survey (MRFSS) combined with the 1997 Add-on MRFSS Economic Survey (AMES) and the follow-up telephone survey for the Southeastern United States (NMFS, 2001b; QuanTech, 1998). Data collection occurred in two-month waves, over the course of a year, from March 1997 through February 1998. The model of recreational fishing behavior relies on the subset that includes only single-day trips to sites located in the study area, excluding respondents missing data on key variables (e.g., home ZIP code). This truncation resulted in a sample of 1,183 anglers, fishing from 52 sites in the study area. The NMFS surveys are described in more detail in Chapter A10.

The Agency included both single- and multiple-day trips in estimating the total economic gain from improvements in fishing site quality from reduced I&E. Details of this analysis are provided in Section D5-3 of this chapter.

### D5-1.1 Angler Characteristics

#### a. Fishing modes and targeted species

The majority of anglers in the sample (67 percent) fish from a private or rental boat; 29 percent fish from shore; and only four percent fish from charter boats. The Agency evaluated five species and species groups in the model:

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- ▶ drums (including red and black drum)
- ▶ spotted seatrout,
- ▶ gamefish,
- ▶ snapper-grouper, and
- ▶ other.<sup>1</sup>

Effects of changes in catch rates for particular species in the drums, gamefish and snapper-grouper categories can still be estimated because the catch rates for the combined categories are weighted averages.

Table D5-1 shows species targeted by fishing mode and for all modes, and table D5-2 compares species targeted on the intercepted trip to species generally targeted. EPA calculated species targeted on the intercepted trip based on anglers' reported first and second primary targets. If the angler's first target was in the "other" category and the second target was a species of interest, the observation was included in the observations with the targeted species. Such observations were excluded from the "other" species category. For the species of interest, 21.5 percent of anglers target gamefish<sup>2</sup>, 16.2 percent target spotted seatrout, 16.5 percent target snapper-grouper<sup>3</sup>, and 12.3 percent target drums.

**Table D5-1: Species Group Choice by Mode of Fishing**

Species	All Modes		Private/rental boat		Party/charter boat		Shore	
	Frequency	Percent	Frequency	Percent by Mode	Frequency	Percent by Mode	Frequency	Percent by Mode
No Target	376	31.78%	203	25.5%	12	26.1%	161	47.1%
Other	20	1.69%	11	1.38%	0	0.0%	9	2.6%
Drums	146	12.34%	124	15.6%	1	2.2%	21	6.1%
Spotted Seatrout	192	16.23%	171	21.5%	0	0.0%	21	6.1 %
Gamefish	254	21.47%	157	19.8%	11	23.9%	86	25.2%
Snapper-Grouper	195	16.48%	129	16.2%	22	47.8%	44	12.9 %
All Species	1,183	100.00%	795	100%	46	100%	342	100%

**Table D5-2: Generally Targeted Species vs. Species Targeted on Intercepted Trip**

Species	Generally Target		Targeted on Intercepted Trip	
	Number	Percent	Number	Percent
Drums	344	29.1	146	12.3
Spotted Seatrout	77	6.5	192	16.2
Gamefish	197	16.7	254	21.5
Snapper-Grouper	193	16.3	195	16.5

<sup>1</sup> "Other" species may include the following species families or genus: herring, puffer, eel, skate, sardine, sunfish, skate, ray, requiem shark.

<sup>2</sup> Gamefish include snook, king mackerel, Spanish mackerel, pompano, permit, cobia, Atlantic tarpon, hammerhead shark, mackerels, and tunas.

<sup>3</sup> Snapper-grouper include miscellaneous groupers in the *epinephelus* and *mycteroperca* groups, red grouper, gag grouper, other miscellaneous groupers, snapper, gray snapper, sea bass, jacks, grunt, hogfish, and sheephead.

Almost 32 percent of the sample did not target a particular species on the intercepted trip. An additional 2 percent target a species in the “other” category. Around 40 percent of the “no-target” anglers do not generally target a species. Of those “no target” anglers who do generally target a species, 33 percent generally target drums, 25 percent generally target snapper-grouper, 15 percent generally target gamefish, and seven percent generally target spotted seatrout.

The distribution of target species is not uniform by fishing mode. For example, while 15.6 percent of private/rental boat anglers target drums, only 6.1 percent of shore anglers, and 2.2 percent of charter boat anglers target drums. While 21.5 percent of boat anglers target spotted seatrout, only 6.1% of shore anglers, and no charter boat anglers target spotted seatrout. The percentages for gamefish do not differ greatly, with 25.2 percent of shore anglers targeting gamefish, and 19.8 percent and 23.9 percent of boat and charter boat anglers, respectively, targeting gamefish. A large number of charter boat anglers (47.8 percent) target snapper-grouper, while 16.2 percent of boat anglers and 12.9 percent of shore anglers target fish in this category.

### b. Summary of angler characteristics

Almost 62 percent of the anglers in the sample own a boat (729/1183), including 26 percent of anglers intercepted on a charter trip, 78 percent of anglers intercepted on a boat trip, and 27 percent of anglers intercepted on shore.

Of the 394 boat and charter anglers reporting the distance traveled from shore, 74 percent (291) fished ten miles or less from shore and 26 percent (103) fished more than ten miles from shore. Eighty-two percent of charter anglers who reported distance from shore fished more than ten miles from shore, and 22 percent of private/rental boat anglers who reported distance fished more than ten miles from shore. Of the 1,182 anglers reporting, 1,166 or 98.7 percent fished with hook and line, five (.4 percent) fished with cast net, ten (.85 percent) fished with spear, and one (.08 percent) fished with a hand line.

Seventy-seven percent of the 1,161 anglers reporting employment status are employed. Of those who are not employed, 64 percent are retired. Approximately 93 percent of those reporting employment status work full-time, seven percent work part-time, and less than one percent are variably or seasonally employed. Approximately 46 percent receive a salary rather than an hourly wage. Almost 91 percent of the sample are male, and 94 percent are white. Table D5-3 summarizes angler characteristics.

The study compared boat, charter, and shore mode anglers to investigate any important differences among the groups. Table D5-4 compares demographics by fishing mode. Anglers who prefer different fishing modes do not appear to differ greatly in terms of demographics.

<b>Variable</b>	<b>Mean<sup>a</sup></b>	<b>Std Dev</b>	<b>Min</b>	<b>Max</b>
Male	0.90	0.29	0	1
White (N=1,152)	0.94	0.24	0	1
Employed (N=1,161)	0.77	0.42	0	1
Retired	0.14	0.35	0	1
Owns a boat	0.62	0.49	0	1
Age in Years (N=1,157)	42.84	14.1	16	95
Household Income	\$47,521	\$28,420	\$7,500	\$200,000
# of Years Fishing Experience (N=1,146)	21.19	14.6	0	80

<sup>a</sup> For dummy variables such as “Owns a Boat” that take the value of 0 or 1, the reported value represents a portion of the survey respondents possessing the relevant characteristic. For example, 62 percent of the surveyed anglers own a boat.

**Table D5-4: Comparison of Boat, Charter, and Shore Mode Anglers**

	Mean	Standard. Deviation	Minimum	Maximum
Shore income	\$40,212	\$23,859	\$7,500	\$200,000
Boat income	\$50,229	\$29,491	\$7,500	\$200,000
Charter income	\$55,054	\$31,013	\$20,000	\$137,500
Shore age	43.6	15.6	16	93
Boat age	42.4	13.4	16	95
Charter age	45.1	14.1	16	75
Shore years fished	19.3	15.4	0	70
Boat years fished	22.0	14.3	0	80
Charter years fished	20.7	14.0	0	50

### c. Number of trips

Table D5-5 shows the number of trips taken in the last twelve months by mode and generally targeted species. Charter boat anglers tend to fish significantly less often than boat or shore anglers. However, there is not a large difference in activity among anglers who target different species often.

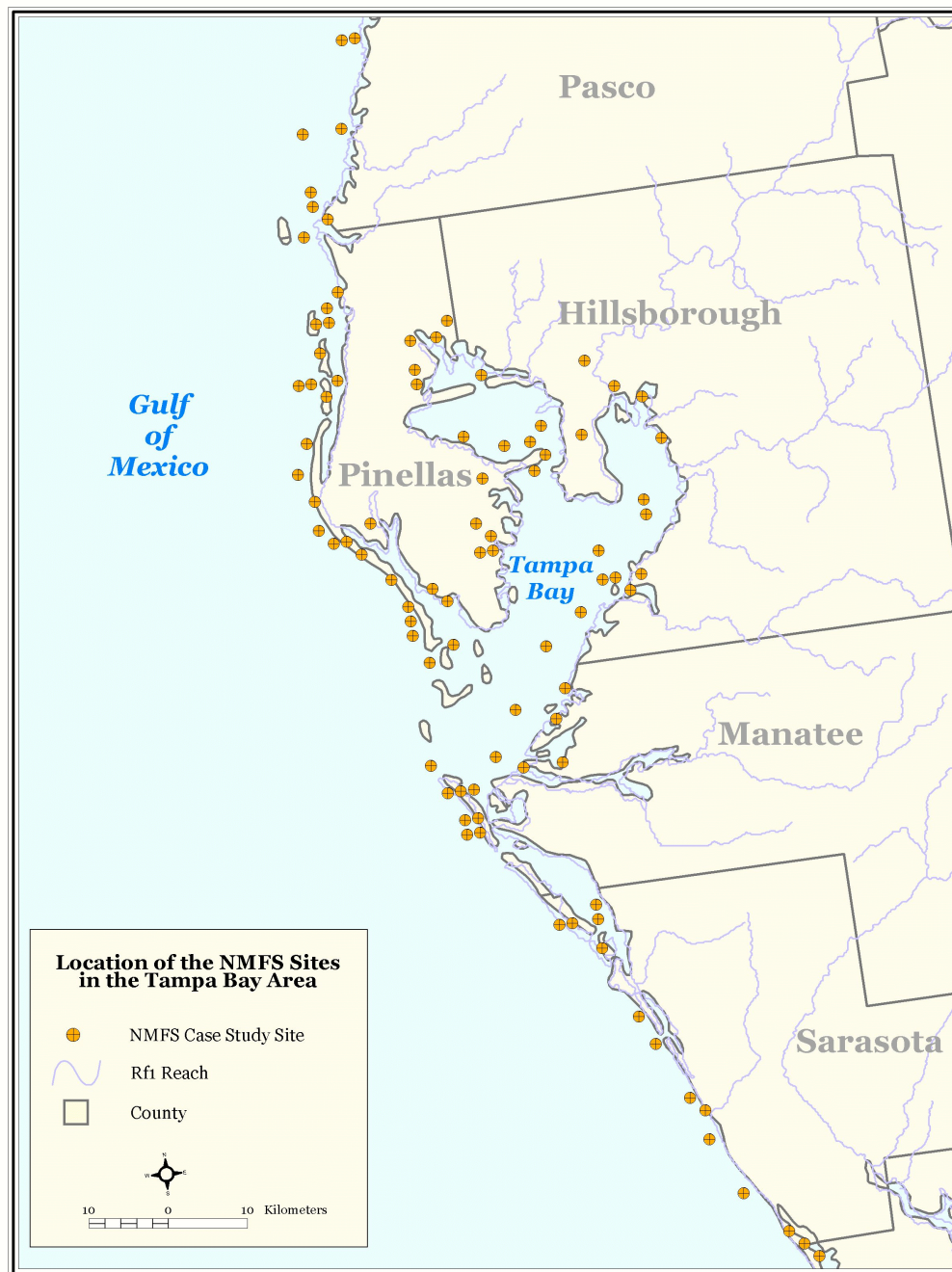
**Table D5-5: Number of Trips by Mode and Generally Targeted Species**

Variable	Number of Anglers	Mean # Trips	Standard Deviation	Min	Max
<b>Fishing Mode</b>					
Charter	46	22.17	55.81	0	300
Pvt/rental	778	53.54	55.96	0	360
Shore	339	60.28	71.06	0	364
<b>Generally Targeted Species</b>					
Drums	339	59.23	59.73	0	300
Spotted seatrout	75	53.24	66.86	1	364
Gamefish	194	72.45	74.04	0	364
Snapper-grouper	192	40.52	43.00	0	300

## D5-1.2 Choice Sets

The National Marine Fisheries Service (NMFS) intercept sites included in the analysis are depicted in Figure D5-1. There are 52 fishing sites, and the analysis assumes that every angler faces the full choice set, since the region studied is relatively small. In other words, each angler will potentially fish at any of the 52 locations in the area. Table D5-6 shows the number of observations and intercept sites for each county.

Figure D5-1: NMFS Intercept Sites Included in RUM Analysis





**Table D5-6: Number of Anglers Intercepted at NMFS Sites by County**

County	Number of Observations	Percent of Sample	Number of Intercept Sites
Pasco	247	20.88	5
Pinellas	462	39.05	20
Hillsborough	242	20.46	11
Manatee	146	12.34	8
Sarasota	86	7.27	8
Total	1,183	100	52

### D5-1.3 Site Attributes

The model uses catch rates for the species of interest, as well as the presence of boat ramps and marinas to measure site quality. Catch rate is the most important attribute of a fishing site from the angler's perspective (McConnell and Strand, 1994; Haab et al., 2000). This attribute is also a policy variable of concern because catch rate is a function of fish abundance, which is affected by fish mortality due to I&E. The catch rate variable in the RUM therefore provides the means to measure baseline losses in I&E and changes in anglers' welfare attributed to changes from I&E due to the 316b rule.

To specify the fishing quality of the case study sites, EPA calculated historic catch rate based on the NMFS catch rate from 1995 to 1997. The catch rates represent the number of fish caught on a fishing trip divided by the number of hours spent fishing: the number of fish caught per hour per angler. The estimated catch rates are averages across all anglers in a given year over the three-year period. The gamefish and snapper-grouper catch rates are weighted average catch rates for all species in the group, weighted by the proportion of sample for each species. The no target anglers were assumed to face an average catch rate calculated as a weighted average of all species, using the percent who generally target each species as the weights.

EPA estimated the catch rate for each combination of recreational fishing zone in the study area and fish species of interest using a standard Inverse Distance Weighted (IDW) interpolation technique. The IDW technique estimates a value for any given location by assuming that each input value has an influence on that location. This influence diminishes with distance according to a squared distance value. If available, EPA used observable catch rate values for a given site to estimate average catch rates for that site. If no observed catch rates were found, EPA used an inverse distance squared estimation technique to calculate an average catch rate for a given zone/species combination. The Agency first located any site visits within five kilometers from a given fishing zone and then used the catch rates of the nearest four sites visited as input values for calculating historic catch rates for the species in question.

Some RUM studies have used predicted, rather than actual, catch rates (Haab et al., 2000; Hicks et al., 1999; McConnell and Strand, 1994). This practice allows for individual characteristics to affect catch rates; for example, anglers with different levels of experience may have different catch rates. Haab et al. (2000) compared historic catch and keep rates to predicted catch and keep rates and found that historic catch and keep rates were a better measure of site quality. They also found that the choice of catch rate had little effect on the travel cost parameters. Hicks et al. (1999) found that using historical catch rates resulted in more conservative welfare estimates than predicted catch rate models. Consequently, EPA favored this more conservative approach.

The NMFS surveys collect two catch rate measures: total catch (including fish discarded or used for bait), and fish caught and kept, which were available for measurement by the interviewer. Some of the NMFS studies use the catch and keep measure as the relevant catch rate. Although greater error may be associated with measured numbers of fish not kept, the total catch measure is most appropriate in the Tampa area because a large number of anglers catch and release fish. There are many reasons for fish releases, including:

- ▶ Enjoyment of the sport rather than fish consumption;
- ▶ Environmental regulations (e.g., bag limits for recreational fish species);
- ▶ Individual concerns about dwindling fish stocks; and
- ▶ Concerns over possible pollutants in fish caught.

Some fish of particular interest, e.g., tarpon, are never kept. Table D5-7 shows the average catch rates by species. On average, the “other” species category has the highest catch rate, followed by spotted seatrout, drums, snapper-grouper, and gamefish.

<b>Table D5-7: Average Catch Rate by Species/Species Group (fish per angler per hour)</b>			
<b>Species/Species Group</b>	<b>Average Catch Rate (fish per angler per hour)</b>		
	<b>Shore Mode</b>	<b>Boat Mode</b>	<b>Shore and Boat Modes</b>
Drums	0.312	0.524	0.446
Spotted Seatrout	0.792	1.168	1.157
Gamefish	0.281	0.351	0.325
Snapper-Grouper	0.267	0.499	0.404
Other Species	2.635	2.118	2.051

### D5-1.4 Travel Cost

EPA estimated trip “price” for each angler as the sum of travel costs plus the opportunity cost of time, following the procedure described in Haab et al. (2000). Based on Parsons and Kealy (1992), this study assumed that time spent “on-site” is constant across sites and can be ignored in the price calculation.

EPA used ZipFip software to calculate the one-way distance to each site for each angler.<sup>4</sup> Several people reported out-of-state Zip codes, and were deleted from the analysis. Although the analysis could not determine whether the reported Zip codes are accurate measures of anglers’ trip origins, interviewers asked respondents for the Zip code of their winter residence rather than their permanent residence.<sup>5</sup> The analysis therefore assumes that anglers are traveling from the Zip code reported in the data.<sup>6</sup> The average estimated one-way distance to the site visited is 15.1 miles.

To estimate anglers’ travel costs, EPA multiplied round-trip distance by average motor vehicle cost per mile (\$0.31, 1997 dollars).<sup>7</sup> The model adds the opportunity cost of travel time, measured in terms of wages lost, to the travel cost for those who would have lost income by taking the fishing trip. For these anglers the dummy variable LOSEINC equals one. Travel times equal the round-trip distance divided by a travel speed of 40 mph and multiplied by the angler’s hourly wage as calculated below.

The travel cost variable in the model was calculated as follows:

$$\text{Visit Price} = \begin{cases} \text{Round Trip Distance} \times \$0.31 + \frac{\text{Round Trip Distance}}{40 \text{ mph}} \times (\text{Wage}) & \text{If LOSEINC} = 1 \\ \text{Round Trip Distance} \times \$0.31 & \text{If LOSEINC} = 0 \end{cases} \quad \text{Eq. D5-1}$$

<sup>4</sup> The program was created by Daniel Hellerstein and is available through the USDA at <http://usda.maunlib.cornell.edu/datasets/general/93014>.

<sup>5</sup> Correspondence with an economist at NMFS (Amy Guatam, NMFS Economist, September 2001).

<sup>6</sup> Thirteen observations where estimated travel time did not closely approximate reported travel times were deleted from the analysis, because of unreliable travel time estimates.

<sup>7</sup> EPA used the Federal Travel Regulations mileage reimbursement rate for June 7, 1996 – September 8, 1998 (FTR Amendment 48). This estimate includes vehicle operating costs only.

The analysis assumes that anglers whose incomes are not flexible (e.g., people on salary), do not consider the dollar cost of the time given up to travel to a recreational site. These anglers still have an opportunity cost for their travel time, which could otherwise be spent doing something else, like fishing. In other words, a shorter distance traveled allows for a longer time spent fishing. For these anglers, the analysis included an additional round-trip travel time variable calculated as:

$$\text{Travel Time} = \begin{cases} \text{Round Trip Distance}/40 & \text{If } \text{LOSEINC} = 0 \\ 0 & \text{If } \text{LOSEINC} = 1 \end{cases} \quad \text{Eq. D5-2}$$

The average one-way estimated travel time to the visited site is 22.7 minutes, while the average reported travel time is 29.7 minutes. This discrepancy is due to the difference between actual and measured travel miles.

The model identified anglers who lost income while traveling by creating the LOSEINC dummy variable as follows. Approximately seven percent of respondents who answered (62/909), reported that they lost income during their fishing trip. The analysis used other information to infer responses in the case of 274 anglers who did not answer this question. Most of the 274 anglers (267/274) reported being unemployed, while others reported receiving a salary rather than an hourly wage; the model assumed that these anglers did not lose income by taking the fishing trip. Four respondents (less than one percent) provided insufficient information to determine employment status. To be conservative, the analysis assumed that these individuals did not lose income.

The data set lacked 415 values (35 percent of responses) for household income. The analysis imputed incomes for these anglers by first converting household income categories to dollar amounts using the category midpoints. For income category “>\$175,000,” the analysis capped the income variable at \$200,000, following Haab et al. (2000).

Next, the analysis used a regression analysis to predict the missing values of income in a data set with observations for all variables considered important in determining household income. The analysis regressed the log of household’s category midpoint income on factors hypothesized to influence income. The estimated regression equation used in wage calculation is:

$$\begin{aligned} \ln(\text{Income}) = & 0.14 \times \text{male} + 0.10 \times \text{age} - 0.0017 \times \text{age}^2 + 0.32 \times \text{employed} \\ & + 0.15 \times \text{boatown} + 0.81 \log(\text{stinc}) \end{aligned} \quad \text{Eq. D5-3}$$

where:

INCOME	=	the reported household income;
MALE	=	1 for males and 0 otherwise;
AGE	=	age in years;
EMPLOYED	=	1 if the respondent is currently employed and 0 otherwise;
BOATOWN	=	1 if the respondent owns a boat and 0 otherwise; and
STINC	=	the average income of residents in Florida <sup>8</sup>

The average state income variable has the largest coefficient (0.81) and therefore explains most of the variability in income, followed by employment, then gender and boat ownership, with age having the smallest influence. The model R<sup>2</sup> is .9967. Based on this model, the predicted average household income for anglers who did not report income is \$40,785 per year.

EPA estimated household wage by dividing household income by 2,080 (i.e., the number of full time hours potentially worked). Table D5-8 shows summary statistics for reported travel time and expenses for the intercepted trip.

<sup>8</sup> The average income for Florida is \$31,900, based on Haab, et. al, 2000.



**Table D5-8: Summary of Statistics for Travel Cost and Trip Expenses**

	Minimum	Maximum	Mean	Standard Deviation
Household hourly wage	\$3.61	\$96.15	\$22.85	\$13.66
Travel cost	\$1.32	\$173.78	\$21.20	\$16.12
Reported Round trip travel time (hours)	0	25	.50	.83
Reported expenses (travel+other)	\$0	\$610	\$14.94	\$26.19
Reported expenses (travel+other+boat fee)	\$0	\$1,620	\$21.37	\$66.25

## D5-2 SITE CHOICE MODEL

This section presents results of the RUM, estimated using a conditional logit model for site choice. In the conditional logit model estimated here, the measurable component of utility is estimated as:

$$v_j(k) = \beta_1 TC_j(k) + \beta_2 TT_j(k) + \beta_3 RAMP-MAR_j + \sum_s \gamma_s d_s SQRTQ_{js}(k) \quad \text{Eq. D5-4}$$

where:

$TC_j(k)$	=	travel cost to site $j$ for angler $k$ ;
$TT_j(k)$	=	travel time to site $j$ for angler $k$ ;
$SQRTQ_{js}(k)$	=	square root of the historic catch rate for species $s$ at site $j$ ;
$d_s$	=	dummy variable set equal to 1 if species $s$ is chosen;
$RAMP-MAR_j$	=	presence of boat ramp or marina at site $j$ ; and
$\beta$ and $\gamma$ parameters	=	marginal utilities for each variable.

The analysis used the square root of the catch rate to allow for decreasing marginal utility of catching fish (McConnell and Strand 1994). The analysis therefore models the probability of choosing site  $j$  as:

$$Prob(j) = \frac{\exp[\beta_1 TC_j(k) + \beta_2 TT_j(k) + \beta_3 RAMP-MAR_j + \sum_s \gamma_s SQRTQ_{js}(k)]}{\sum_h \exp[\beta_1 TC_h(k) + \beta_2 TT_h(k) + \beta_3 RAMP-MAR_j + \sum_s \gamma_s SQRTQ_{hs}(k)]} \quad \text{Eq. D5-5}$$

where  $h \neq j$  and  $h = 1, \dots, J$ .

The analysis assumes that each angler in the estimated model considers site quality based on the catch rate for targeted species, and the presence of boat ramps and marinas at the site. The model multiplies a dummy variable for species targeted by the catch rate for each species, so that each angler's observation in the data set will include the catch rate for only the targeted species, with all other catch rates set to zero. "No target" anglers, who may catch a variety of species, were assumed to face a catch rate that was a weighted average of all five catch rates, weighted by the percent of "no target" anglers who generally target each species or species group.<sup>9</sup>

Recreational fishing models often use a nested structure, assuming that anglers first choose a mode and species and then a site. The nested logit model generally avoids the independence of irrelevant alternatives (IIA) problem, in which sites with similar characteristics that are not included in the model have correlated error terms.<sup>10</sup> The nested structure based on mode/species and then site choice therefore assumes that sites selected for certain modes and/or species have similar characteristics.

<sup>9</sup> No target anglers actually caught fish in all categories. Most of the fish caught by no target anglers on the intercepted trip were in the "other" category. Eight percent of fish caught and kept were a species of interest, and 17 percent of fish caught and released were a species of interest.

<sup>10</sup> The IIA property follows from the assumption that the error terms are independent. Sites sharing characteristics not included in the model (e.g., salt water versus freshwater sites) will have correlated error terms, thus violating the IIA property.

Similarities between sites in the Tampa region data set are not clearly distinguished in terms of mode and species. Several mode/species combinations are fished at the same sites. Also, the likely differences among all Tampa region sites make the IIA problem likely to be insignificant. The analysis therefore uses a non-nested RUM in which anglers compare sites and choose the one offering the highest utility level for each trip occasion.

The analysis tested various alternative model specifications, but the model presented here was most successful at explaining the probability of selecting a site.<sup>11</sup> Models with dummy variable interactions between mode and site and species and site did not produce statistically significant interactions. A model with an interaction term between “no-target” anglers and the catch rate for other species found that this interaction was not significant, implying that the “other” target anglers and “no-target” anglers do not differ significantly. This conclusion makes sense, based on summary statistics for “no-target” anglers presented in the data section.

The analysis also ran separate models by mode and species. These models included each site/species combination as a separate choice. Software limitations required the 52 sites to be aggregated into 15 composite sites for these models, yielding 75 separate site/species choices. These models did not explain the variations in data as well as the single model with 52 site choices.

The best model presented here is a site choice model that includes boat mode anglers for all species. This analysis therefore models only site choice and assumes that each angler has chosen a mode/species followed by a site based on the catch rate for that site and species.

Table D5-9 presents model results. All coefficients, except for the other species catch rate, are significant at the 95<sup>th</sup> percentile or better, with expected signs. The results indicate that the average angler who targets a species most highly values snapper-grouper, followed by gamefish, drums, spotted seatrout, and other species. Travel time (TT) is more important than travel cost (TC) in determining whether the average angler would travel farther to a specific site. A site with a boat ramp or marina is more likely to be selected by an angler fishing by boat.

<b>Variable</b>	<b>Coefficient</b>	<b>T-Statistic</b>
TC	-0.116	-7.28
TT	-2.070	-8.95
SQRT(Q <sub>drums</sub> )	1.435	2.50
SQRT(Q <sub>spotted seatrout</sub> )	0.954	2.29
SQRT(Q <sub>game fish</sub> )	2.274	2.76
SQRT(Q <sub>snapper-grouper</sub> )	2.511	6.08
SQRT(Q <sub>no target</sub> )	2.907	4.99
SQRT(Q <sub>other species</sub> )	-0.108	-0.14
Ramp_Mar	0.248	3.12

<sup>a</sup> Discrete choice (multinomial logit) model: Maximum Likelihood Estimates

### D5-3 TRIP PARTICIPATION MODEL

EPA also examined the effects of changes in fishing circumstances on an individual's choice concerning the number of trips to take during a recreation season. EPA used the negative binomial form of the Poisson regression model to estimate the number of fishing trips per recreational season. The participation model relies on socioeconomic data and estimates of individual utility (the inclusive value) derived from the site choice model (Parsons et al., 1999; Feather et al., 1995). This section discusses results from the negative binomial model of recreational fishing participation, including statistical and theoretical implications of the model. A detailed discussion of the Poisson model is presented in Chapter A10 of Part A.

<sup>11</sup> All RUM and Poisson models were estimated with LIMDEP™ software (Greene, 1995).

The dependent variable, the number of recreational trips within the past 12 months, is an integer value ranging from 0 to 365. To avoid overprediction of the number of fishing trips, EPA set the number of trips for anglers reporting over 200 trips per year to 200 in the model estimation.<sup>12</sup>

Table D5-10 shows the negative binomial model results. The variables in the final model are:

IVBASE	=	the inclusive value for each angler from the RUM;
MALE	=	1 if male;
OWN_BOAT	=	1 if person owns a boat and fishes by pvt_rental mode;
DRTARG	=	1 if drums are generally targeted;
GATARG	=	1 if gamefish are generally targeted; and
ALPHA	=	overdispersion coefficient.

The analysis used the angler's "generally targeted" species, rather than species targeted on the intercepted day, to interpret the RDTARG and GATARG variables. See the data section for more detail.

All parameters are significant, with expected signs. The results indicate that anglers with higher values per trip, as indicated by the IVBASE variable, males, boat owners who fish by boat, and those targeting drums and gamefish, will take more fishing trips per year.

Additional tested variables were not statistically significant. These variables include whether the angler is employed, retired, unemployed (including retired people), a homemaker or student, or white; the angler's age; years of fishing experience; income; and whether the angler generally targets spotted seatrout or generally targets snapper-grouper.

Table D5-10: Negative Binomial Model Results <sup>a</sup>		
Variable	Coefficient	T-Statistic
Constant	3.281	21.29
IVBASE	0.049	3.26
MALE	0.217	1.76
Own_BOAT	0.255	3.20
DRTARG	0.214	2.80
GATARG	0.356	3.78
Overdispersion Parameter for Negative Binomial Model		
Alpha	0.863	20.27

<sup>a</sup> Negative binomial regression Maximum Likelihood estimates

## D5-4 WELFARE ESTIMATES

This section presents estimates of welfare losses to recreational anglers from fish mortality due to I&E, and potential welfare gains from improvements in fishing opportunities due to reduced fish mortality stemming from the 316b rule.

### D5-4.1 Estimating Changes in the Quality of Fishing Sites

To estimate changes in the quality of fishing sites under different policy scenarios, EPA relied on the recreational fishery landings data by state and the estimates of recreational losses from I&E on the relevant species at the Tampa Bay CWISs. The National Marine Fisheries Service provided the recreational fishery landings data for western Florida for the main species

<sup>12</sup> The number of trips was truncated at the 95<sup>th</sup> percentile, 200 trips per year according to NMFS recommendations (NMFS, 2001b).

affected by I&E. These species are black drum, spotted seatrout, and sheepshead.<sup>13,14</sup> EPA estimated the losses to recreational fisheries using the impacts of I&E on the relevant fish species and the percentage of total fishery landings attributed to the recreational fishery, as described in Chapter D3.

The Agency estimated changes in the quality of recreational fishing sites under different policy scenarios in terms of the percentage change in the historic catch rate. EPA assumed that catch rates will change uniformly across all marine fishing sites in the Tampa Bay region, because species considered in this analysis inhabit a wide range that extends beyond the region of interest (Pattillo, et al., 1997). EPA used the average recreational landings for a 3-year period (1997 through 1999), for sites within State waters.<sup>15</sup> EPA then divided I&E losses to the recreational fishery by the total recreational landings for the Tampa Bay area for each species of concern to calculate the percent change in historic catch rate from baseline losses (i.e., eliminating I&E completely). Table D5-11 presents results of this analysis.

<b>Table D5-11: Estimated Changes in Catch Rates from Eliminating all I&amp;E of Black Drum, Spotted Seatrout and Sheepshead</b>				
<b>Species</b>	<b>Estimated Fishery I&amp;E (number of fish/year)</b>		<b>Total Recreational Landings for Tampa Region (fish/year)</b>	<b>Percent Increase in Recreational Catch from Elimination of I&amp;E</b>
	<b>Number of Fish Impinged</b>	<b>Number of Fish Entrained</b>		
Black Drum	54,449 I&E <sup>a</sup>		72,233	75.38%
Spotted Seatrout	5,183	16,726	5,411,292	0.40%
Sheepshead <sup>b</sup>	0	248	783,407	0.03%

<sup>a</sup> Total I&E for black drum was calculated based on a cap value of 54,449 fish. This value was calculated based on the average black drum recreational landings for a period of five years (1981 to 1986).

<sup>b</sup> Sheepshead belongs to the snapper grouper species category.

EPA also estimated values for changes in the quality of recreational fishing sites for an increase in the catch rate by one fish of each species at all sites.

## D5-4.2 Estimating Benefits from Eliminating I&E in the Tampa Bay Region

The recreational behavior model described in the preceding sections provides a means for estimating the economic effects of changes in recreational fishery losses from I&E in the Tampa Bay region. First, EPA estimated welfare gain to recreational anglers from eliminating fishery losses due to I&E. This estimate represents economic damages to recreational anglers from I&E of recreational fish species in the Tampa Bay region under the baseline scenario.

EPA estimated anglers' willingness to pay for improvements in the quality of recreational fishing due to I&E elimination by first calculating an average per trip welfare gain based on the expected changes in catch rates from eliminating I&E.

<sup>13</sup> Sheepshead belongs to the snapper grouper species category.

<sup>14</sup> Pinfish and silver perch were also affected by I&E. However, NMFS does not provide recreational landings data for these species, and these species are included in the "other species" category in this analysis, and thus did not have significant values to anglers in our sample. Thus, these species were not included in the I&E welfare analysis.

<sup>15</sup> State waters include sounds, inlets, tidal portions of rivers, bay, estuaries and other areas of salt or brackish water; and ocean waters to 3 nautical miles offshore (NMFS, 2001b).

### a. Per trip/per additional fish benefits

Table D5-12 presents the compensating variation per trip (averaged over all anglers in the sample) associated with reduced fish mortality from eliminating I&E for each fish species of concern;<sup>16</sup> and for a one fish catch rate increase for each species.<sup>17</sup>

<b>Table D5-12: Per Trip Welfare Gain from Eliminating I&amp;E of Drums, Spotted Seatrout and Sheepshead in the Tampa Bay Region (2000\$)</b>		
<b>Targeted Species</b>	<b>Per Trip Welfare Gain from Elimination of I&amp;E</b>	<b>WTP for an Additional Fish per Trip</b>
Black and Red Drums	--	\$3.66
Black Drum	\$7.04	--
Spotted Seatrout	\$1.76	\$2.80
Gamefish	--	\$5.46
Snapper-Grouper (includes sheepshead)	\$1.74	\$5.15

The results show that anglers targeting black drum have the largest per trip welfare gain (\$7.04) from eliminating I&E in the Tampa region. Anglers targeting spotted seatrout and sheepshead have smaller per-trip gains (\$.176 and \$1.74 respectively). The large gains for black drum are due to the large predicted increase in catch rates. In general, based on a one fish per trip increase in catch rate, gamefish and snapper-grouper are the most highly valued fish in the study area, followed by drums and spotted seatrout. Haab, et al. (2000) report a range of values for a unit increase in catch per trip, using the 1997 MRFSS data for western Florida. The values estimated for the Tampa area are consistent with their estimates. Haab et al. estimated values for increasing an angler's catch by one fish per trip. The estimated values for snapper-grouper range from \$3.78 to \$5.58; the authors' values for spotted seatrout range from \$0.31 to \$1.09; and their estimated values for red drum range from \$3.68 to \$16.92.<sup>18,19</sup> They do not estimate values for gamefish, but do estimate values for coastal migratory pelagic fish, which range from \$2.92 to \$26.30.<sup>20</sup>

### b. Estimating total participation

EPA calculated total economic values by combining the estimated per trip welfare gain with the total number of trips to sites in the Tampa Bay region. NMFS provided information on the total number of fishing trips for western Florida. EPA estimated the number of trips for the case study area by first calculating the percent of total intercept surveys from western Florida conducted in the Tampa Bay case study area (48.04%). Multiplying the total number of trips in western Florida by the estimated percent of intercept surveys in the Tampa Bay area yields the number of fishing trips in the study area.

The total number of trips includes both single- and multiple-day trips, with multiple day trips expanded to estimated fishing days by NMFS.<sup>21</sup> The Agency assumed that the welfare gain per day of fishing is independent of the number of days fished per trip and therefore equivalent for single- and multiple-day trips. Table D5-13 presents the estimated number of days fished by mode for the Tampa Bay Region.

<sup>16</sup> A compensating variation equates the expected value of realized utility under the baseline and post-compliance conditions. For more detail see Chapter A10 of Part A.

<sup>17</sup> The one fish per trip increase was converted to .24 fish per hour, based on an average trip length of 4.1 hours.

<sup>18</sup> Haab et al. (2000) report their dollar estimates in 1997 dollars. Their estimates have been converted to 2000\$ here for purposes of comparison.

<sup>19</sup> EPA's estimate for drums is on the low end of the estimates from Haab et al. (2000). However, Haab et al.'s values are for red drum, while EPA's estimate is for both black and red drum. Black drum is not as highly valued by anglers as red drum (Pattillo et al., 1997).

<sup>20</sup> Haab et al.'s (2000) coastal migratory pelagic group includes bluefish, cobia, dolphin, king mackerel, Spanish mackerel, cero, and little tunny. EPA's gamefish group includes hammerhead shark, snook, king mackerel, Spanish mackerel, pompano, cobia, tuna, and Atlantic tarpon.

<sup>21</sup> Based on email communication with NMFS staff (Alan Lowther, NMFS Statistician, January 2001).

**Table D-13: Recreational Fishing Participation by Fishing Mode**

<b>Fishing Mode</b>	<b>Total Number of Fishing Days per Year in Tampa Case Study Area</b>
Private and/or Rental Boats	3,285,506
Shore	2,783,465
Charter Boat	361,258
<b>Total</b>	<b>6,430,229</b>

Source: NMFS, 2001b.

Per trip welfare gains differ across recreational species. EPA therefore estimated the number of fishing trips associated with each species of concern. Again, EPA used the MRFSS sample to calculate the proportion of recreational fishing trips taken by anglers targeting each species of concern, and applied these percentages to the total number of trips to estimate species-specific participation. Table D5-14 shows the calculation results.<sup>22</sup> For all fishing modes, anglers targeting gamefish take the most trips each year, followed by those targeting snapper-grouper, drums, and spotted seatrout. The number of trips for anglers targeting black drum was calculated by multiplying total trips for drums by the percent of drum anglers who generally target black drum. The number of sheepshead trips was calculated in a similar manner, based on snapper-grouper trips.

The estimated number of trips represents the baseline level of participation. Anglers may take more fishing trips when fishing quality improves. EPA used the estimated trip participation model to estimate the percentage change in the number of fishing trips with the elimination of I&E, and for a one fish per trip increase in catch rates at each site. For elimination of I&E, the estimated percentage increases are .93% for anglers who target sheepshead, .94% for anglers who target spotted seatrout, and 3.82% for anglers who target black drum. For a 1 fish increase in catch rates, the estimated percentage increases range from 1.5 percent for anglers who target spotted seatrout, to 2.95 percent for anglers who target gamefish. The increased number of trips are shown in Table D5-14.

### **c. Estimating total benefits to Tampa Bay anglers**

Table D5-15 provides welfare estimates for the two policy scenarios: the elimination of I&E in the Tampa region, and a one fish per trip increase in catch rates. For elimination of I&E, total benefits would be \$2,380,303 per year estimated at the baseline number of trips, and \$2,410,288 per year estimated at the predicted increased number of trips. For a one fish increase, for all fishing modes, total benefits would be \$23.1 million per year estimated at the baseline number of trips, and \$23.7 million per year estimated at the predicted increased number of trips.

<sup>22</sup> The number of trips shown includes trips taken by anglers who did not target on the intercepted trip. The number of trips for “no target” anglers for each species was calculated based on the total number of no target anglers multiplied by the percent of no target anglers who generally target each species.



Table D5-14: Recreational Fishing Participation by Species and Fishing Mode

Species	Mode: Private Rental Boats Number of Fishing Days			Mode: Shore Number of Fishing Days			Mode: Charter Boat Number of Fishing Days			Total Number of Fishing Days per Year		
	Baseline	With Improved Fishing Quality		Baseline	With Improved Fishing Quality		Baseline	With Improved Fishing Quality		Baseline	With Improved Fishing Quality	
		Elimina- tion of I&E	+ 1 Fish <sup>a</sup>		Elimina- tion of I&E	+ 1 Fish <sup>a</sup>		Elimina- tion of I&E	+ 1 Fish <sup>a</sup>		Elimina- tion of I&E	+ 1 Fish <sup>a</sup>
Drums	719,133	--	733,312	358,169	--	365,231	15,691	--	16,000	1,195,656	--	1,219,231
Black Drum	22,598	23,461	--	11,255	11,685	--	493	512	--	37,571	39,007	--
Spotted Seatrout	752,175	759,248	763,469	203,404	205,317	206,458	--	--	--	1,125,163	1,142,057	1,135,743
Gamefish	735,618	--	757,323	789,546	--	812,842	102,089	--	105,101	1,565,305	--	1,611,490
Snapper- Grouper	681,955	--	700,938	496,616	--	510,440	204,204	--	209,888	1,369,500	--	1,407,621
Sheepshead	39,984	40,357	--	29,118	29,389	--	11,973	12,084	--	80,296	81,045	--

<sup>a</sup> An increase in the total catch per trip by one fish corresponds to an approximately 20 percent increase in catch rate.

<b>Table D5-15: Total Welfare Estimates for I&amp;E Baseline Losses and 1 fish Increase in Catch Rates (2000\$)</b>				
<b>Species</b>	<b>+ 1 Fish</b>		<b>Baseline I&amp;E Losses</b>	
	<b>Low Value</b>	<b>High Value</b>	<b>Low Value</b>	<b>High Value</b>
Drums (Red and Black)	\$4,380,788	\$4,467,163	--	--
Black Drum	--	--	\$264,651	\$274,451
Spotted Seatrout	\$3,146,749	\$3,193,998	\$1,976,135	\$1,994,717
Gamefish	\$8,541,457	\$8,793,479	--	--
Snapper-Grouper	\$7,055,717	\$7,252,116	--	--
Sheepshead	--	--	\$139,817	\$141,121
<b>Totals</b>	<b>\$23,124,711</b>	<b>\$23,706,756</b>	<b>\$2,380,303</b>	<b>\$2,410,288</b>

## D5-5 LIMITATIONS AND UNCERTAINTY

### D5-5.1 Site Quality

The Tampa Bay model uses historic catch rates and the presence of boat ramps and marinas as the sole measures of site quality. Other potential measures of quality are omitted. These might include the size of fish caught or the likelihood of catching a large fish. Other site quality variables related to aesthetics and amenities of sites might also be important. However, EPA was unable to obtain adequate data on any of these variables.

### D5-5.2 Extrapolating Single-Day Trip Results to Estimate Benefits from Multiple-Day Trips

Use of per day welfare gain estimated for single-day trips to estimate per day welfare gain associated with multiple-day trips can either understate or overstate benefits to anglers taking multiple-day trips. Inclusion of multi-day trips in the model of recreational anglers' behavior can be problematic because multi-day trips are frequently multi-activity trips. An individual might travel a substantial distance, participate in several recreation activities including shopping and sightseeing, all as part of one trip. Recreational benefits from improved recreational opportunities for the primary activity are overstated if all travel costs are treated as though they apply to the one recreational activity of interest. EPA therefore limited the recreational behavior model to single-day trips only and then extrapolated single-day trip results to estimate benefits to anglers taking multiple-day trips.

### D5-5.3 Considering Only Recreational Values

This study understates the total benefits of improvements in fishing site quality because estimates are limited to recreation benefits. Many other forms of benefits, such as habitat values for a variety of species (in addition to recreational fish), nonuse values, etc., are also likely to be important.

### D5-5.4 Sources of Survey Bias

#### a. Recall bias

Recall bias can occur when respondents are asked, such as in the NDS survey, the number of their recreation days over the previous season. Some researchers believe that recall bias tends to lead to the number of recreation days being overstated, particularly by more avid participants. Avid participants tend to overstate the number of recreation days because they count days in a "typical" week and then multiply them by the number of weeks in the recreation season. They often neglect to consider days missed due to bad weather, illness, travel, or when fulfilling "atypical" obligations. Some studies also found that the more salient the activity, the more "optimistic" the respondent tends to be in estimating the number of recreation days. Individuals may also overstate the number of days they participate in activities that they enjoy and value. Taken together, these sources of recall bias may result in an overstatement of the actual number of recreation days.

**b. Sampling effects**

Recreational demand studies frequently face observations that do not fit general recreation patterns, such as observations of avid participants. These participants can be problematic because they claim to participate in an activity an inordinate number of times. This reported level of activity is sometimes correct but often overstated, perhaps due to recall bias. Even where the reports are correct, these observations tend to be overly influential. EPA set the upper limit of the number of fishing trips per year to 200 days to correct for potential bias caused by these observations when estimating trip participation models. Note that the Agency used the NMFS estimate of the baseline number of trips that was corrected for avidity bias. The estimated participation model was used for estimating percentage change in total participation in the Tampa Bay area. Therefore, sampling effects are unlikely to have a significant impact on welfare estimates.

**c. Modeling**

The model necessarily assumes that trips are independent choice occasions because it uses data for an individual intercepted trip for each angler to predict behavior. The model does not account for the fact that choices regarding trips across a season or year might be correlated. The Tampa Bay case study does not use mode-specific catch rates in the model. The inclusion of catch rates by mode and site might capture differences in value by mode.